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Going Mobile — Slowly

How Wireline Telephone Regulation Slows Cellular Network Development

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In this issue ...

Canada has been extraordinarily slow to roll out digital cellular networks, and ranks near the bottom of OECD nations in per capita cellular telephone subscriptions. If Canadians want a better range of cellular network services at lower cost, they should look for fresh approaches to regulation and competition at the CRTC.

The Study in Brief

The cellular telephone's convenience and commercial usefulness has changed social and business communication. Yet Canada's pace in adopting cellular telephony lags most developed countries: Canada was the twenty-sixth among the 30 OECD nations to introduce digital cellular, and is currently twenty-eighth in per capita cellular subscriptions.

Neither is Canada adapting as quickly as many developing countries, where cellular phones already dominate in local voice service and new investment in wireline is largely confined to building data network capacity. Within a few years, cellphones will become the preeminent communication device for email, voice and digital photography in many countries; over the same horizon, Canadians will be relatively slow to share in the benefits of cellular provision of these services.

One of the causes of Canadians' slowness to adopt cellular telephony is our regulatory policy: in particular, long-standing cross-subsidies maintain artificially low wireline prices, reducing cellular's relative competitiveness and incentives to invest in better quality, expanded cellular coverage.

Because relatively few Canadians have "cut the cord," replacing their wireline service with cellular only, the Canadian Radio-television and Telecommunications Commission (CRTC) believes that cellular service is not an effective competitor with wireline service. Accordingly, the CRTC has maintained regulatory control over retail and wholesale wireline rates and set local retail rates at very low levels — undermining the cellular market. Further, the CRTC's recent decision on voice over Internet protocol (VoIP) telephony effectively limits competition between VoIP service providers and incumbent local carriers, and will result in higher-than-otherwise prices for VoIP and slower and less extensive rollout.

What to do? First, the CRTC should use an alternative to universal low prices for local wireline service to address any equity issues associated with local phone service. Second, the CRTC should acknowledge that despite being differentiated products, wireline and cellular services compete with each other and should be freed to do so. Third, policymakers should reconsider foreign ownership restrictions in the context of this competitive marketplace.

Without these regulatory improvements, Canadians may find themselves largely bypassed by the generation of cellular services that are at the cutting edge of telecommunications technology in every other OECD country.

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The increasingly ubiquitous use of cellular telephones has changed the patterns of both social and business communication fundamentally, for it is now generally expected that those who have cellphones will always be available to receive business or personal calls. As a result, most developed countries are at, or rapidly moving toward, the point where there are more cellular than wireline subscribers, where the majority of voice calls are carried on the cellular networks, and where the development of wireline networks is concentrating on data and Internet traffic because voice traffic alone is no longer sufficient to sustain ubiquitous subscription to wireline local access services. In developing countries where there was not much investment in wireline infrastructure in the second half of the twentieth century, cellular phones already provide the most common form of local voice access, and new investment in fixed-wire networks is largely confined to providing data capability.

Canada lags behind most OECD countries in the adoption of cellular telephony. Among the 30 OECD countries, Canada was the twenty-sixth to introduce digital (2G) cellular technology and is currently twenty-eighth in per capita cell phone subscriptions. Thus, even compared to other countries with universal wireline service, Canada has been slow to adopt cellular telephony. So while in many countries analysts are predicting that within a few years cell phones will be the pre-eminent communication device used by consumers for e-mail, voice calls and digital photography, over the same period a smaller proportion of Canadians will receive the benefits of a cellular subscription that provides all of these services.

In this paper we argue that one of the causes for the slowness of Canadians to adopt cellular telephony is our regulatory policy. In particular, Canada's long-standing use of subsidies to maintain artificially low wireline prices has reduced cellular penetration. Thus fewer Canadians have "cut the cord" to replace their wireline service with cellular only. This has led the Canadian Radio-television and Telecommunications Commission (CRTC) to conclude that cellular service is not an effective substitute for wireline service. As a result, the CRTC believes the only competition that matters for assessing the competitiveness of local voice-access markets is that provided by local wireline networks. And since there are few competing providers of wireline services, the CRTC has maintained regulatory control over retail and wholesale rates and, in particular, has set retail local rates at levels that are very low by international standards. Market definition and regulatory pricing are related in this instance because recognition of the convergence between the markets for cellular and wireline telephony would also require the recognition of the wider competitive market of which wireline telephony is a part.

The CRTC's recent decision on voice over Internet protocol (VoIP) telephony is an extension of this view of competitive conditions. In its decision, the CRTC (2005a) establishes a regulatory regime that protects various VoIP service

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The authors of this *Commentary* have worked for incumbent telephone companies and for competitors. In recent work, Ms. Sanderson filed an expert report for Aliant as part of its application to the Canadian Radio-television and Telecommunications Commission for forbearance from regulation of local exchange services in certain exchanges in Nova Scotia and Prince Edward Island. Professor Quigley and Ms. Sanderson filed an expert report for Bell Canada as part of its application for forbearance in high-speed digital network services.

providers from competition from incumbent local exchange carriers (ILECs). The CRTC believes it is protecting competition by protecting VoIP "competitors." This is misguided. Although Decision 2005-28 will certainly encourage customers to transfer from the ILECs to VoIP competitors, it will also result in higher prices for VoIP than would exist without this decision. In addition, the spread of VoIP service throughout Canada is likely to be slower and less extensive with regulation of ILECs' VoIP services than it would otherwise be. By failing to consider the wider competitive environment, the CRTC maintains extensive regulatory control over ILEC retail wireline services at a time when technological advances — either by cellular or VoIP — are undermining the case for regulation of retail prices and for universal retail wireline service obligations.[1]

We begin by outlining the economic theory used to determine substitutes and the extent of competition in defined markets. We then consider the economic implications of regulatory policy that mandates low retail prices for basic services provided by an old technology, but by doing so inhibits the adoption of competing technologies. We then discuss cellular telephony services, pricing and uptake in Canada; and the empirical evidence on competition between cellular and wireline telephony in Canada and in other countries. Finally, we offer some suggestions for improvements in Canadian regulatory policy.

Competition and Market Definition

Competition may be thought of as the process generated by rivalry between firms. Rivalry occurs through the introduction of new and improved products and services over time, and through the setting of prices at a particular point in time. Economists assess the intensity of competition by examining the ability of each firm to exercise market power by setting prices above the competitive level.[2] The exercise of market power by a firm offering a particular good is constrained by the availability of close substitutes from other firms. These are the products or services that can be said to "compete" with the good in question. The process of identifying those competing products or services is known as market definition. Market definition is usually the first task of competition authorities trying to foresee the likely competitive effects of a merger or a particular business practice.

Telecommunications regulators also define relevant markets as a preliminary step in assessing the extent of competition in order to determine whether regulation is needed and, if so, how much is needed. For example, section 34 of the Telecommunications Act requires the CRTC to "forbear" from regulation if it finds that "a telecommunications service or class of services provided by a Canadian carrier is or will be subject to competition sufficient to protect the

1 An exception occurs in the situation where a single telecommunications company is dominant in the provision of residential voice services, whether delivered by cellular, VoIP or wireline. There will also still be a case for wholesale regulation of access to essential facilities when these are controlled by the incumbent and are needed by rivals in order to provide competing service.

2 Market power may also be defined with respect to a material, non-transitory reduction in other factors of competition, such as service, quality, variety, advertising or innovation. For ease of reference, market power is referred to here with respect to price increases, but it should be understood to include also non-price factors of competition.

interests of users." The CRTC has indicated that the interests of users are protected when markets are workably competitive but that workable competition does not exist if a dominant firm has substantial market power as demonstrated by its ability to set prices above competitive levels for a sustained period of time.[3]

Because it is difficult to measure directly whether a firm has market power,[4] regulators and competition authorities normally define the relevant product and geographic markets and then consider the extent of competition within those markets. Competition is assessed by considering the individual participants' market shares, demand and supply conditions, behaviour of customers, effectiveness of rivals against the incumbent firm and the prospects for future entry or expansion of rival firms.[5] In telecommunications, the pace and direction of technical change will be relevant to any assessment of the potential for existing firms to expand and for other firms to enter the market. It may also be relevant to consider other factors, such as regulation and those bearing on the ability to raise prices significantly above competitive levels.

When products are homogeneous, the market definition exercise is relatively straightforward, but usually they are not. The existence of differentiated products complicates the market definition exercise because the characteristics that distinguish one product from another may vary continuously as existing products are improved upon and new ones introduced.

In the case of differentiated products, simple comparisons of price are not an adequate basis for market definition or analysis of competitive constraints on firms. For example, cellular is differentiated from local wireline service by the fact that each service has unique features, but in particular by the fact that cellular service has features that consumers consider so valuable that it is priced higher as a result. A simplistic interpretation might suggest that the seller of local wireline could raise its price without inducing consumers to switch to cellular. But when the mobility of cellular makes the service more valuable to consumers, the fact that it has a higher price says nothing about the willingness of consumers to switch to it in response to monopoly pricing of the less valuable service.

Another complication can arise when different customers consider services to be competing or complementary to varying degrees. For instance, suppose that many consumers regard two services as complementary, in the sense that an increase in the price of one decreases the demand for the other, and vice versa. If

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3 The focus on substantial market power is important because market power is present to some degree in most markets. For example, product differentiation and brand loyalty may provide some market power to individual competitors in the market, but the investments underlying differentiation and brand awareness result from a competitive process that provides net benefits to consumers. Similarly, when technology is changing rapidly, a firm may obtain short-term market power from a new product but consumers obtain net benefits from the stimulus to innovation that is provided by the attempts of competitors to produce a superior product.

4 Market power can be directly measured if the responsiveness of customers' purchases to increases in the firm's price is known. If customers can easily switch to other products or services in the face of a small increase in price, demand is said to be "elastic." If, in the face of a small increase in price, rivals can easily increase their production of the products or services or reallocate existing productive capacity in order to produce the products or services, supply is said to be elastic.

5 These factors were recognized by the CRTC as important to consider in forbearance applications in its Decision 94-19 (CRTC 1994, 66-69).

the proportion of such consumers is very large, then the price of one service is not constrained by the availability of the other. However, if a significant number of people view the services as substitutes and, as a result, are willing to switch in response to a price increase in the other, the two goods would then be said to be competing, despite the existence of a number of people that regard them as complementary. It is not necessary for everyone to view the goods as substitutes in order to find that they are competing. So, the fact that some people resist using cellular phones or use them only for special purposes (such as emergency use) is not inconsistent with competition between cellular and wireless service so long as a substantial group of consumers does regard them as substitutes.

In the extreme case, product differentiation can result in regulators or competition authorities refusing to recognize the true breadth of the market until one of the products is viewed by consumers as virtually obsolete. In our view it is unreasonable to wait to recognize cellular telephony as a substitute for wireline telephony until the prices and services offered by cellular networks result in mass extinction of fixed-line telephone subscriptions. It should be recognized that, for many consumers, the common local service provided by both networks, the potential for cellular service to make wireline local service redundant, and the pricing of both services on a per minute basis put them in the same market.

The difficulty of defining the market in the case of differentiated products is one of the reasons why competition law in New Zealand and Australia calls for the adoption of market boundaries that are consistent with "commercial common sense" as well as those that can easily be demonstrated with the quantitative tools of economists.[6] Here the application of common sense suggests that regulators should consider the extent to which wireless and wireline networks offer competing services rather than allow the differences in functionality and prices to hide the obvious substitutability of their core local and long distance calling capability.

In contrast to its position on wireless, the CRTC focused on functional substitution when it found that because VoIP telephone numbers conform to the North American Numbering Plan and the service connects with the Public Switched Telephone Network (PSTN), local VoIP services are in the same market as circuit-switched local services.[7] But wireless also conforms to the North American Numbering Plan, and it too connects with the PSTN, just as VoIP service does, yet the CRTC does not regard wireless as a substitute for local wireline service. But if functional substitution is paramount, the CRTC's logic suggests that VoIP is in competition with all forms of circuit-switched telephony — both local and long-distance — as well as with wireless service, since all of these services allow for calls to and from the PSTN. This disconnect in logic was pointed out by

6 Section 3(1A) of the New Zealand Commerce Act defines a market as "a market in New Zealand for goods or services as well as for other goods or services that, as a matter of fact and commercial common sense, are substitutable for them."

7 The CRTC (2005a) defined the defining characteristics of VoIP services in paragraph 63 of Telecom Decision CRTC 2005-28. It goes on to conclude that the fundamental purpose of VoIP is the same as that of circuit-switched local exchange services (para. 113) and that consumers will see local VoIP service as a replacement for circuit-switched local exchange service (para. 124). As a result, the CRTC concludes that local VoIP services are close substitutes for circuit-switched local exchange services and hence are part of the same relevant market (para. 126). It goes on ....

Andrée Wylie, dissenting Commissioner and Vice-Chair (CRTC 2005a). The CRTC did not consider wireless to be a close substitute for wireline telephone service because fewer than 2 percent of Canadian households were wireless-only as of 2003 (CRTC 2005a, 128). But by December 2004, the number of wireless-only households in some cities had grown to nearly 6 percent (Statistics Canada 2004a),[8] which is considerably higher than VoIP penetration (admittedly VoIP was introduced more recently).[9]

Despite these trends, telecommunications regulators in Canada and other developed countries have traditionally taken the view that wireline and cellular telephony are different enough to be competing in different markets. As a result, the CRTC has not considered the extent of wireless competition when setting retail and wholesale wireline rates, requiring contribution payments[10] and restricting the local exchange carriers' range of competitive responses.[11] On the other hand, there is no regulation of cellular providers, including the ILEC cellular providers, which are considered subject to competitive constraint. But as cellular coverage spreads, as the cost of cell phones, access and termination falls, and as more of the total voice traffic is carried over cellular systems, wireless and wireline service converge.

The extent of competition between wireline and cellular networks was addressed by the U.S. Federal Communications Commission (FCC) when it considered the acquisition of AT&T Wireless Services, Inc. by Cingular Wireless Corporation.[12] In this decision, the FCC's examination of the competitive effects of

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footnote 7 cont'd.

to find that because the incumbent local exchange carriers have market power in local exchange services, they will have market power in the relevant market that includes local VoIP service and hence should continue to be regulated (para. 131-132). The CRTC undertakes a separate section 34 analysis and comes to the same conclusions (para. 170-171).

8 These statistics were released in May 2005. In Vancouver, 5.8 percent of households were wireless-only. In Canada as a whole, 2.7 percent of households were wireless-only in December 2004.

9 VoIP is predicted by industry analysts to capture a significant fraction of traditional residential wireline access lines. RBC Capital Markets Research analysts Richard Talbot and Jonathan Allen (2005, 4-5) predict Bell and Telus will lose 19 percent of their business to VoIP competitors over the next five years.

10 Effective January 1, 2001, the CRTC introduced a revenue-based contribution regime to subsidize local telephone service in high-cost rural and remote areas of Canada. Under this regime, Canadian telephone companies, long distance providers, wireless service providers and resellers contribute a percentage of their eligible revenues to a national fund, which is then distributed to appropriate residential local telephone service providers (CRTC 2004).

11 For example, ILECs can be subject to "winback" rules that prevent them from soliciting lost customers for a particular period of time.

12 Even though the FCC did not consider wireless providers to be competitively constrained by local wireline telephony providers, it did find that after the merger, AT&T Wireless may have less incentive to continue offering service packages designed to induce consumers to switch their wireline service to wireless, because Cingular is jointly owned by two providers of local voice access wireline services (United States 2004, paragraph 246). In the end, the FCC found there were enough other independent cellular providers — both national and regional — that the loss of a single independent cellular carrier "should have only a small adverse effect on the overall level of intermodal competition" (United States 2004, paragraph 248). Hence the limited harm to the public interest from the loss of AT&T Wireless as an independent cellular carrier did not outweigh the potential benefits to the public interest.

a merger between two cellular carriers went beyond local cellular markets to include the impact on the competitiveness of local voice markets. In Canada, the Competition Bureau considered whether wireline telephony was an effective substitute for wireless service when it examined the competitive effects of the acquisition of Microcell Telecommunications Inc. by Rogers Wireless Inc., but it did not appear to consider how this merger would affect wireline substitution (Competition Bureau 2005).

The effects of narrow regulatory definitions is not limited to cellular local-access telephony. The CRTC's recent VoIP decision illustrates how regulation may limit competition by restricting the freedom of the ILECs to offer, at attractive prices, the VoIP services that consumers want and by making the ILECs less able to compete with the other providers of VoIP services. It is generally agreed that Decision 2005-28 is likely to lead to higher prices for Canadian customers of VoIP than would otherwise be the case. For example, Seaboard commentators Brian Sharwood and Ian Grant (2005, 3) said that with Decision 2005-28, "the Commission has succeeded in keeping telephone rates higher than need be for most Canadians." RBC Capital Markets analysts Richard Talbot and Jonathan Allen (2005, 1) predicted that, "while the incumbents will face accelerating competitive line losses and margin pressure following this Decision, the financial impact would have been much the same under a deregulation scenario, as the telcos ... would cannibalize their own margins to maintain market share" — presumably by cutting prices to customers. The Coalition for Competitive Telecommunications, which represents business and institutional telecom users, expressed similar views. Having found that the majority of business leaders surveyed did not want the CRTC to regulate VoIP, Ian Russell, Coalition Chair, noted: "While the CRTC apparently believes that users will benefit from their new VoIP rules, one must ask who knows better what users want: the CRTC or the users themselves"? (Canada News Wire 2005).

Dynamic Competition and Market Convergence

Beyond the effect on prices, regulating the price of a new and evolving product such as VoIP can also have detrimental effects on investment and thus on dynamic efficiency. If firms have less incentive to invest because regulation makes ILECs less able to attract VoIP customers, and this is borne out in a slower rate of new service introduction or a more limited geographical reach, rival firms such as the cable incumbents will not introduce new products or services as quickly or as broadly, because there will be less competitive pressure to do so.

The availability of new products or services is one of the major ways in which consumers benefit from competitive markets. When firms compete for incumbency by introducing new products or services, the rivalry between them is known as dynamic competition. In order to make the necessary investments to develop new goods and services, firms must have the prospect of making a profit. This is particularly so when there is competition "for the market" and the firm that introduces the first or best new product expects to take a dominant position until it is usurped by another firm offering its innovation. Such a situation is found in the market for computer software and hardware. In these situations, the

innovator profits when consumers abandon the older technology in favour of the new.

The fact that successful firms must earn profits to justify engaging in dynamic competition means that, by definition, prices in dynamically competitive markets depart from short-run marginal cost. Thus, there are consumers who would be willing to pay just above short-run marginal cost but who are unable to purchase the good — there is some degree of short-run market power. On the other hand, to the extent that a new product or service creates consumer surplus that did not exist previously, any static allocative inefficiency from pricing above short-run marginal cost must be balanced against dynamic welfare gains over time (Quigley 2004).

An implication of dynamic competition in the regulatory context is that although it may seem optimal from a static perspective to ensure that firms do not possess any market power, pricing above short-run marginal cost provides the motivation for firms to enter and "out-innovate" the incumbent firm, thereby fuelling growth and innovation over time. This is a strong reason not to regulate prices at levels near short-run marginal cost (Evans, Quigley and Zhang 2003).

This conclusion holds in two distinct, but related, cases. Firms in many regulated industries must make recurring fixed and irreversible investments in order to maintain and improve the quality of their product. But firms will be unwilling to do that if they expect regulation to drive prices to short-run marginal cost. A price structure that allows firms to recover the cost of their investments, such as average cost pricing or, more generally, Ramsey pricing, provides better incentives to make the investments that generate new products and services.[13]

A second reason for tolerating pricing above short-run marginal cost comes from considering a competitive process that is more explicitly dynamic in nature. Many regulated industries are changing rapidly because of competitive threats from a variety of newer technologies. Firms that are competing to offer the next generation of products or services depend on being able to earn profits to recoup the investments made in the process of dynamic competition. If firms expect regulation to limit the profits available from offering services that use those technologies, the intensity of dynamic competition will suffer and with it the timeliness of new products and services being made available to consumers. When regulation results in a reduction in investment or a delay in the introduction of new services, the costs to society can be very high. The reason is that if the services are not offered or are offered at a much lower scale than they would be without efficient regulatory policy, both consumers and producers suffer because the entire market or section of the market is absent.[14] The benefits that consumers receive from low regulated prices will generally be much smaller than the costs

13 The theory of efficient pricing by a multi-product firm requires the goods sold to relatively price-insensitive consumers to be marked up above cost more than the goods sold to price-sensitive consumers. This is known as Ramsey pricing. This allows for fixed costs to be recovered with minimal distortion to overall consumption levels.

14 Technically, both the consumer and producer surplus associated with the sale of the service or product are lost to society.

that result from the absence of services that consumers would otherwise adopt.[15] The costs of regulatory policy that results in inefficiently small incentives to invest in new technologies are compounded by the reduction in economic growth that results from slower development and adoption of innovations.[16]

The concept of dynamic competition also helps to explain what it means to say that products or services are "competing." In the static context we think of one firm as competing with another when it prevents a hypothetical monopolist in the first service from pricing that service as if it were a monopoly. Similarly, a service promotes dynamic efficiency when it threatens either to replace or to pre-empt the other.[17] We do not need to go so far as to say that the two services should be thought of as being in the same product market, but it is helpful to realize that competing products are not just those that can be substituted for one another at a particular time; they are also those that compete in the long term.

Dynamic, investment-based competition can therefore change the market structure from one in which complementary products co-exist to one where a new version of a product becomes a substitute. Thus, the current market structure may be transitory and may also be a poor measure of monopoly power in the long run.[18]

The U.S. antitrust case involving Microsoft is a useful example of this. The U.S. Department of Justice, in taking the case against Microsoft, alleged that Microsoft had tried to monopolize the market for operating systems, partly by bundling its Internet Explorer browser with its Windows operating systems. Microsoft responded to these allegations by arguing that its browser and operating system were complements and that consumers derive enhanced benefits when the browser and operating system are used together through the bundling by Microsoft. One of the key arguments made by the U.S. government, however, was that browser technology, specifically Netscape Navigator, would eventually be able to run software independently of the underlying operating system. Thus the browser alone (or in connection with the Java language) would become a substitute for the combination of the browser and operating system. This would happen only if enough programmers decided it was worthwhile to write

15 In contrast, when there is pure monopoly, society suffers deadweight losses and consumers are made worse off by the transfer of consumer surplus to producer surplus; however, only under very special conditions could the monopolist obtain all of the consumer surplus.

16 The size of the losses resulting from dynamic inefficiency will always be debatable both from the point of view of the counterfactual (the introduction and rate of uptake of the service in a dynamically efficient environment) and the methods of empirical estimation. However, examples of these calculations (such as Hausman 1997b and Goolsbee 2000) are robust enough to support the theoretical conclusion that the losses are large.

17 Consider the classic asymmetric patent race story in which an incumbent sells good A, and both the incumbent and an entrant are racing to replace good A with alternative varieties of "drastic" innovation through good B. In the dynamic sense, both versions of good B are competing to replace good A. In a slightly different sense, the two firms' versions of good B are also competing against each other; the classic patent race supposes that the first firm to realize the invention receives a patent and the ability to perfectly exclude the other. See Reinganum (1989) for details.

18 In innovative competition, one cannot understand the significance of a large market share without understanding how that share came to be and how it is maintained. Similarly, in such circumstances, the number and identity of firms in the market are not immutably given but are determined by the competitive process itself. One must understand that process as a dynamic whole rather than as a static situation (Fisher, McGowan and Greenwood 1983, 43).

applications for this operating-system-independent "middleware." Once enough such applications existed, users would not care which operating system they were actually running, and Microsoft's dominance in operating systems would be in jeopardy. The government claimed that Microsoft was very concerned about this possibility, and was trying to prevent (or delay) it by bundling the products together. In essence, Microsoft recognized that dynamic competition was threatening its current market dominance, despite the fact that a contemporaneous market definition analysis revealed operating systems and browsers to be in separate markets.

In Canada, the marketing efforts of the different cellular providers reveal the extent of substitution between cellular and wireline. First, it is notable that the only firms that have tried to market cellular as a replacement for traditional wireline service in Canada are firms such as Clearnet and Microcell, which are not local wireline incumbents. Second, both Bell and Telus offer more attractive cellular plans in areas outside of their wireline service territory. Telus offers its Ontario cellular customers a 200-minute-anytime plan for the same price as its 175-minute-anytime plan in Alberta.[19] Bell offers to Alberta cellular subscribers an "Extreme $30" plan that includes 100 weekday minutes and 100 Canadian long distance minutes in addition to unlimited nighttime, weekend and incoming calls. No similar plan is available in Ontario. Instead, Bell offers its Ontario cellular subscribers the "All-in-one Nights & Weekends $30" plan with a special bonus of 50 weekday minutes available on a limited time basis, but it charges for long distance and for incoming calls.[20] By offering less attractive cellular prices within their wireline territories, both Bell and Telus are presumably trying to limit the cannibalizing of their wireline service by their cellular service. This would be unnecessary if cellular and wireline were not substitutes.

Cellular Telecommunications Services

Cellular telephony is an excellent example of a service that was originally viewed as complementary (to wireline service) but is becoming an important competitive alternative. First-generation analog cellular service was introduced in the early 1980s. At that time the technology was not advanced enough in call quality and reliability to be comparable to wireline service. Thus, calls made from cellular phones interconnected with calls made over fixed wirelines but did not replace them. But cellular technology has advanced dramatically since then. The latest technology (known as 3G) enables calls to be routed more efficiently and allows networks to route a larger number of calls. Data transfer rates (up to 2Mbps) are much faster. Industry experts say that 3G cellular technology will provide voice service of a quality at least equal to that of the current fixed network (Dornan 2000, 104). 3G technology has been introduced in South Korea, Japan and Europe

19 Telus also offers a 350-anytime-minute plan to Ontario cellular subscribers for the same price as its 300-anytime-minute plan for Alberta cellular subscribers. (See http://www.telusmobility.com/on/plans/pcs/allplanssmall.shtml, and http://www.telusmobility.com/ab/plans/pcs/allplanssmall.shtml.)

20 See http://www.bell.ca/shop/en_CA_AB/PrsShpWlsRtpAIO_Lits.page?wlcs_catalog_category and http://www.bell.ca/shop/en_CA_ON/ZM.details.

but not yet in North America (Brown-Humes and Budden 2004a; Brown-Humes and Ollila 2004b; Budden 2003).

The feature that sets cellular service apart from fixed wireline telephony is mobility, but consumers also value the flexibility and the ability to be the sole owner and user of a telephone.[21] Although consumers have been willing to pay more for those benefits than they pay for wireline connections, cellular prices have fallen considerably. As Figure 1 (and Appendix 1) show, cellular prices on a per-minute basis are now comparable to or even lower than wireline per minute prices depending on when the calls are made.[22]

With the fall in cellular prices, the number of subscribers has increased exponentially (see Figure 2). This is in contrast to wireline access, which has recently stalled after years of keeping pace with the growth of households.

Industry forecasts predict continued growth in cellular services, and hence the replacement of wirelines by cellular should accelerate (see Figure 3).

Although the adoption of cellular service has been growing quickly, the penetration rate in Canada is still low by international standards (IDC 2003a, 4). Industry analysts report that cellular has not yet reached the "mature" stage in the product adoption life cycle (IDC 2003a, 17). This is clear when international comparisons are made. Among the 30 OECD countries, Canada's cellular penetration in 2003 was twenty-eighth. Only Turkey and Mexico had fewer cellular subscribers per 100 inhabitants. Table 1 shows wireline and cellular penetration rates for OECD countries in 2003; whereas Canada ranks low in cellular penetration, it ranks high in wireline penetration.

All the OECD countries with per capita wireline penetration similar to that of Canada or higher have higher cellular penetration than Canada. This can also be seen in Figure 4, which plots cellular and wireline penetration rates. Only Canada and the United States have high wireline penetration rates without having high cellular penetration rates, and Canada's cellular penetration levels are well below those of the United States.

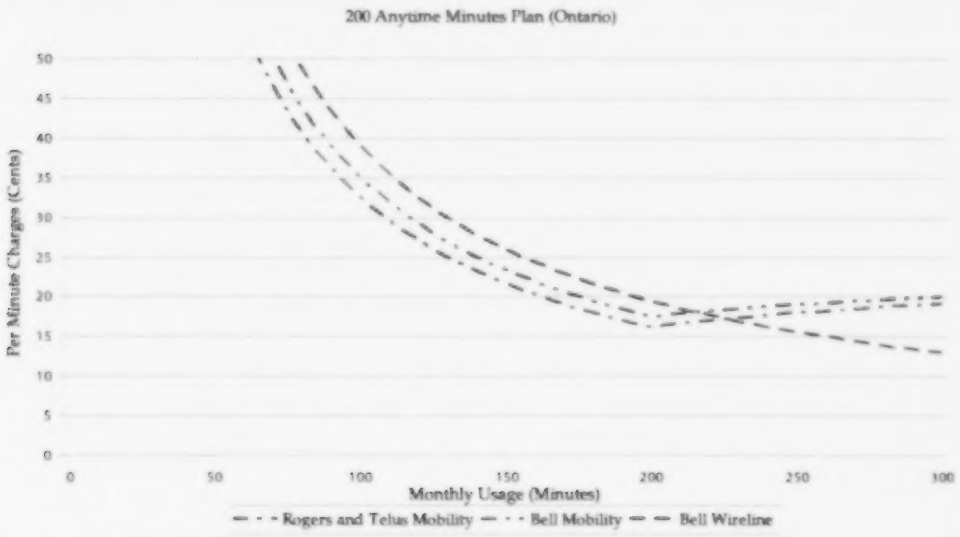
Why is cellular penetration so low in Canada compared to other OECD countries? There are several possible explanations. First, Canada's wireline network may be of higher quality than that found in other countries. Moreover, wireline calls have historically been subject to per-minute charges in Europe and Asia in contrast to Canada. Thus, it may be the unlimited local wireline calling in Canada that has reduced cellular penetration compared to countries where local wireline service is metered. But this explanation fails to explain the higher cellular penetration in Australia, New Zealand and the United States than in Canada, since these countries also have unmetered high-quality local wireline calling. It also ignores the fact that cellular service provides both local access and mobility, whereas wireline networks do not provide mobility no matter how high their quality.

Second, differences in penetration may perhaps be due to differences in the structure of payments for use of the mobile network. In Canada and the United

21 On the other hand, one of the benefits of wireline phones is that they can be shared among members of a household (see Woroch 2002).

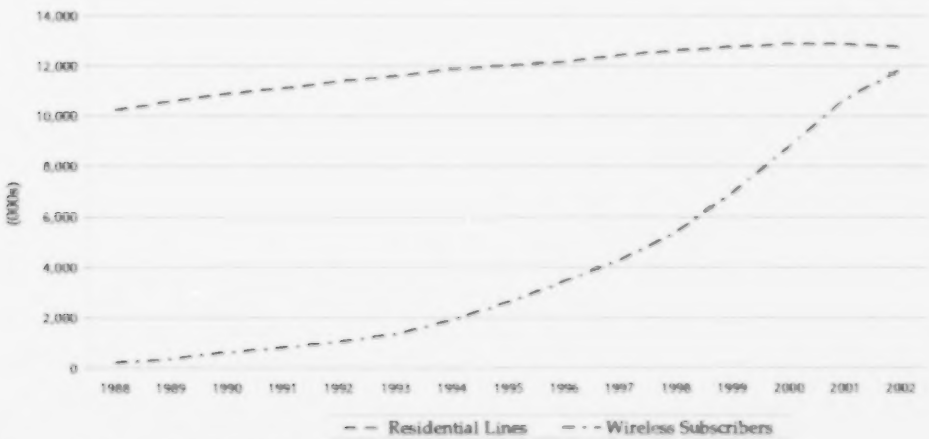
22 As rates depend on when calls are made, we distinguish weekends, weeknights and weekdays.

Figure 1: *Comparison of Cellular and Wireline Prices Per Minute*



Source: Company websites.

Figure 2: *Residential Lines and Cellular Subscribers (1988-2002)*

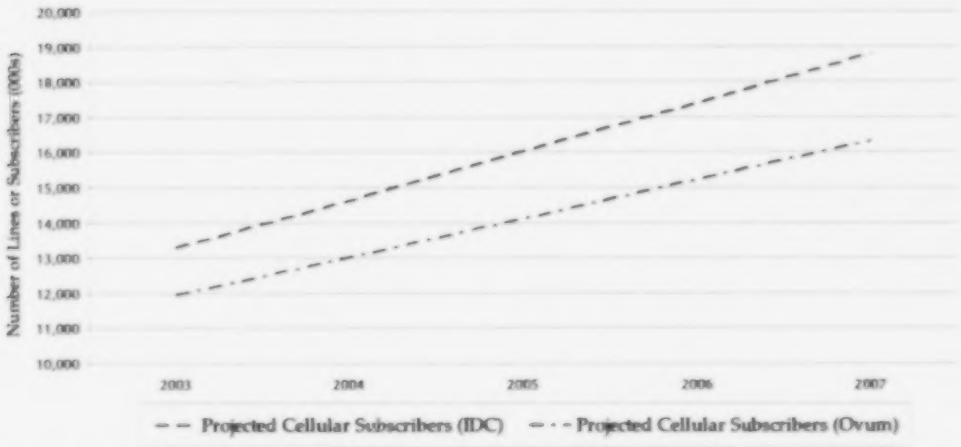


Source: Industry Canada 2004, Table C-1.

States, the mobile party pays for mobile calls, whereas in most other countries the calling party pays. Under the mobile-party-pays (MPP) regime, one would expect consumers to prefer to take incoming calls on a wireline phone if possible, whereas in a calling-party-pays (CPP) system, consumers should not care whether they receive calls on a cellular or a wireline phone.[23] Wright (2002) has also shown that with CPP, per-minute cellular prices tend to be lower and penetration rates higher than with MPP pricing.

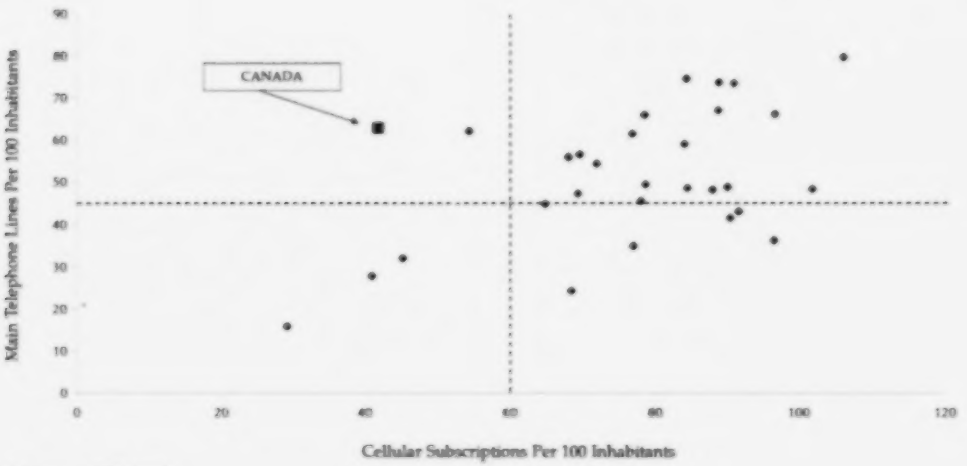
23 Hausman (2002, 595) notes that the increased popularity of cellular plans with large numbers of minutes has diminished this effect to some extent in the United States.

Figure 3: *Projections of Cellular Subscribers (2003-2007)*



Source: IDC 2003a and Ovum 2003.

Figure 4: *Cellular and Wireline Penetration Rates in OECD Countries, 2003*



Source: ITU 2004.

Third, penetration rates may be affected by the way that cellular service is marketed in different countries. The OECD has noted that in Europe prepaid cards are much more popular than in the United States and Canada. Whereas in the United States large numbers of minutes are bundled for a fixed monthly charge, in Europe and Asia-Pacific operators prefer to meter use and include lower numbers of bundled minutes, a system that lends itself more to prepaid plans (OECD 2003, 90).

However, those differences between Europe and North America cannot account for the differences in cellular penetration between Canada and the United States. It is possible that the U.S. cellular market is more competitive than that of

Table 1: *Wireline and Cellular Penetration Rates for OECD Countries, 2003*

Country	Cellular Subscribers per 100 Inhabitants	Cellular Ranking	Main Telephone Lines per 100 Inhabitants	Main Telephone Ranking
1 Australia	71.95	20	54.23	14
2 Austria	87.88	11	48.07	19
3 Belgium[b]	78.56	15	49.44	15
4 Canada	41.68	28	62.90	8
5 Czech Republic	96.46	4	36.03	25
6 Denmark	88.72	10	66.93	5
7 Finland	90.06	8	48.82	16
8 France	69.59	21	56.60	12
9 Germany	78.54	16	65.87	7
10 Greece	78.00	17	45.43	21
11 Hungary	76.88	18	34.86	26
12 Iceland	96.56	3	65.99	6
13 Ireland	84.47	12	48.57	17
14 Italy	101.76	2	48.40	18
15 Japan[a]	67.96	24	55.83	13
16 Korea	69.37	22	47.24	20
17 Luxembourg[b]	106.05	1	79.68	1
18 Mexico	29.11	30	15.77	30
19 Netherlands	76.76	19	61.43	10
20 New Zealand[a]	64.82	25	44.77	22
21 Norway[a]	90.89	6	73.44	4
22 Poland	45.09	27	31.87	27
23 Portugal	90.38	7	41.40	24
24 Slovak Republic	68.42	23	24.08	29
25 Spain	91.61	5	42.91	23
26 Sweden[b]	88.89	9	73.57	3
27 Switzerland[a]	84.34	13	74.42	2
28 Turkey	40.84	29	27.70	28
29 United Kingdom[b]	84.07	14	59.06	11
30 United States	54.30	26	62.13	9

notes: [a] 2002 numbers for main telephone lines per 100 inhabitants only.
[b] 2002 numbers for Cellular Subscribers per 100 inhabitants and Main Telephone Lines per 100 inhabitants.

Source: ITU 2004.

Canada, and hence the prices and options available in the United States are more attractive than those that exist in Canada. And yet the U.S. cellular market is relatively concentrated compared to other U.S. industrial sectors: in 2002, the six national U.S. cellular providers had a combined market share of 80 percent, while another 19 regional providers made up the remaining 20 percent.[24] Recently the number of national U.S. cellular providers was reduced further with the acquisition of AT&T Wireless by Cingular. In Canada, since the acquisition of Microcell by Rogers Wireless, we have only three national cellular providers. As well, compared to the United States, a larger share of Canada's cellular providers

24 This share is based on 2002 FCC data (United States 2003, D-8).

are also providers of local wireline services, a situation that would be expected to weaken the incentive for cellular service providers to compete aggressively against wireline service providers.

Another plausible explanation for the lower take-up of cellular in Canada has to do with the relative price of wireline service, which in this country is heavily regulated. For firms providing cellular service, the expected profits must be sufficient to cover the investments that would be required to achieve higher penetration. Contrast Canada to the United States: cellular prices were nearly the same in both countries in 2003, but wireline prices were considerably lower in Canada (SeaBoard 2003a). Table 2 summarizes the comparison made by SeaBoard of three different types of wireline plans, and also the average of several wireless plans.

While the SeaBoard evidence suggests that in 2003, wireless prices were similar in Canada and the United States, large-minute plans tended to be much cheaper in the United States. Such plans — which offer large numbers of minutes, unlimited use on weekends and at night, and free on-net calling but with the standard cellular features of voice mail, caller ID, three-way calling, call waiting and call forwarding — are a lot like wireline.[25]

The large difference between the prices of cellular and wireline service in Canada by comparison with that in the United States is reflected directly in the expected profitability of investment in cellular technology. This in turn reduces the incentives to make the large sunk investment in cellular networks and technologies that are crucial to the provision of the new and higher-quality services which result in consumer adoption. As Figure 5 demonstrates, capital expenditure on cellular telephony in Canada lagged well behind that in the United States from 1988 to 2003.

In order to understand the reason for this, consider generally the incentive to develop or enhance a new technology that is a substitute for a current product. For both incumbents and entrants, the main determinant of the scale of investment is the expected future profits. If those are low and conditional on successful innovation, firms will invest less. In fact, when investments in new technology are lumpy (i.e., indivisible) and sunk, firms that expect future returns to be too low may choose not to invest at all or may wait until prospects improve. Suppose the price for the established service is limited by regulation, and so returns are low. There may be little incentive to invest heavily in new technology aimed at providing a substitute service if the price for the substitute competes with the low price of the regulated service.

Finally, consider the impact of regulation on investment. It is helpful to think about three types of consumers: those who have only a wireline phone, those who use both wireline and cellular phones and those who use only cellular. Usage substitution can be thought of as an increase in the number of minutes that consumers with both services allocate to their cellular phones (assuming total use remains constant); it can also mean some wireline-only consumers subscribe to a cellular service in addition. Access substitution takes place when either of the first

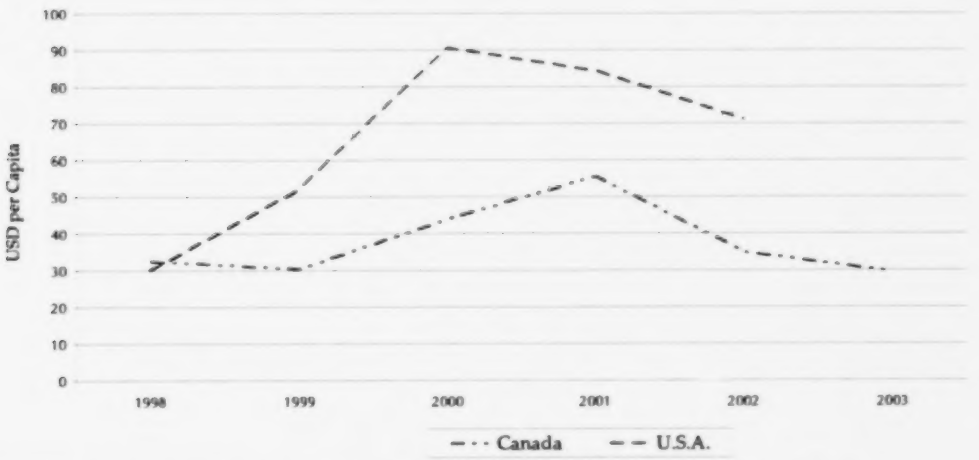
25 Goldman Sachs (2004) notes that such pricing is leading to greater replacement of wireline by wireless, which is borne out by declining number of wireline subscribers and accelerating growth in wireless subscribers.

Table 2: *Summary of SeaBoard Group Study, May 2003*

	Canadian Average	U.S. Average
	US	
Wireline Plan A	USD 19.33	USD 35.72
Wireline Plan B	USD 32.85	USD 56.89
Wireline Plan C	USD 70.76	USD 123.37
Average of Cellular Plans	USD 47.98	USD 46.57

Source: SeaBoard 2003a.

Figure 5: *Capital Expenditure per Capita for Wireless Telecommunications*



Sources: Statistics Canada 2002, 2003a, 2004a; U.S. Census Bureau 2003, 2004; and Bank of Canada.

two types of consumers ends their wireline subscription. In general, an investment that slightly improves cellular quality will tend to lead to both use and access effects. The cost of the investment is thus offset by the increase in profit from both responses.

When the retail price of wireline access is low because of regulation, consumers with only wireline or with both wireline and cellular service will account for a large fraction of total consumers. Consumers with a wireline subscription will be less willing to give this up in response to a small improvement in cellular quality. There will be greater use of cellular but little cutting of the cord. If wireline access were free, there would be no reason ever to stop using it. The result is a smaller additional profit and therefore a diminished incentive to invest (compared to the no-regulation case).

We empirically tested the extent to which low wireline prices influence cellular penetration by employing regression analysis using ITU data from 30 countries

and nine years.[26] We tested the extent to which cellular penetration is "explained" by (1) wireline penetration, (2) cellular revenue per subscriber as a proxy for cellular prices, (3) wireline revenue per subscriber as a measure of wireline prices, (4) the cost of a three-minute local wireline call as another measure of wireline prices, (5) GDP per capita as a measure of income, (6) various control variables for different country fixed effects and (7) control variables for different year effects. Details of the regression analysis are given in the appendix, where we show clear evidence that low wireline prices lead to statistically significantly lower cellular penetration.[27]

In short, cellular penetration depends on increases in product quality or decreases in the quality-adjusted price. Quality depends on investments made by cellular network operators, and investments in turn depend on the regulatory environment. Lower prices for wireline service result in less use of cellular and thus diminished incentives to invest in improved cellular quality, including an expanded geographic cellular footprint.

Cellular Substitution for Wireline in Canada and Elsewhere

The extent to which cellular is substituted for local voice wireline is related to cellular penetration — in countries with very high penetration, consumers are more likely to substitute cellular for wireline. Thus, in Canada, with lower cellular penetration, we expect to find less substitution for wireline than in other countries. The evidence generally supports this proposition. Of the 30 OECD countries, all of which had increases in cellular penetration over time, 16 saw a decline in the number of main telephone lines per household from 2000 to 2002, and the wireline losses in other countries were generally higher than in Canada (Table 3).

The most recent evidence from the United States suggests that since 2000, the incumbent regional Bell wireline operators have lost some 28 million phone-line subscriptions — a drop of more than 18 percent — and it is widely predicted that they will continue to lose wireline subscribers at a rate of around 4 percent a year (Brown and Latour 2004; Goldman Sachs 2004). As a consequence, the number of cellular-only households is growing in the United States, as reported below.[28]

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26 The 30 countries are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The data cover the period 1993 through 2002.

27 When wireline revenue per subscriber is the only wireline price included in the regression, we find that a doubling of real wireline revenue per subscriber leads to 26 to 32 percent higher cellular penetration. If the regressions also include the cost of a three-minute local wireline call during peak hours, the estimated effect is about 20 percent, meaning that holding all else constant, a doubling of the cost of a three-minute local wireline call would increase the number of cellular subscribers per capita by 20 percent.

28 The available evidence suggests that the proportion of cellular-only households may be much higher in some other OECD countries than it is in the United States. For example, DotEcon (2001, 4) reviews evidence showing that 6.7 percent of U.K. households were cellular-only as early as May 2001.

Table 3: *Main Telephone Lines per Household (2000-2002)*

Country	2000	2001	2002	Crowth (2001-2002)
				%
1 Austria	1.22	1.21	1.16	-3.6
2 Belgium	1.25	1.20	1.19	-1.2
3 Canada	1.78	1.71	1.68	-1.7
4 Czech Republic	1.01	1.01	0.96	-4.8
5 Denmark	1.56	1.57	1.50	-4.7
6 Finland	1.21	1.19	1.15	-3.2
7 France	1.40	1.39	1.38	-0.1
8 Hungary	1.01	1.00	0.89	-10.3
9 Iceland	1.92	1.87	1.81	-3.2
10 Japan	1.58	1.53	1.48	-3.1
11 New Zealand	1.36	1.34	1.28	-4.7
12 Slovak Republic	0.88	0.93	0.86	-8.2
13 Spain	1.28	1.29	1.27	-1.6
14 Sweden	1.57	1.56	1.52	-2.5
15 Turkey	1.28	1.29	1.28	-1.4
16 United States	1.77	1.79	1.71	-4.3

Source: ITU 2004.

Data for Canada also show an increase in wireline losses owing to enhanced cellular penetration. Dzieciolowski and Galbraith (2004) examine the cellular and wireline trends in more detail using data from Bell Canada. Their findings suggest that for every 100 new customers subscribing to either cellular or high-speed Internet, 16 primary or secondary wirelines are displaced; that amounts to a reduction of up to 8 percent in the total size of the market for fixed wirelines as of the end of 2003.

As in the United States, the number of Canadian consumers who have replaced their wireline service with cellular is growing. While the number of households with only cellular access remains small, it is growing rapidly: 42 percent more Canadian households reported being wireless-only in December 2004 (at 2.7 percent of households) than in May 2003 (at 1.9 percent of households) (Statistics Canada 2003b and 2004b). Of particular note is the figure for Vancouver, where 5.8 percent of households were wireless-only in December 2004, a rate which is considerably higher than the national average (Statistics Canada 2004b). Vancouver is noteworthy because Microcell began marketing its City Fido service as a replacement for wireline there in October 2003. It is the first major attempt by a cellular carrier to induce consumers to give up wireline access for cellular.[29] Before Rogers acquired Microcell, City Fido gave its customers unlimited local

29 Clearnet introduced a similar marketing strategy in Nova Scotia, but this was abandoned once Telus acquired Clearnet (Seaboard 2003b, 14).

Table 4: *Percentage of Cellular-Only Consumers in the United States*

Date of Estimate	Percentage
November December 2001	1.2 – 2.2
September 2002	3.0
2003	4.9
February 2004	7.0 – 8.0
2004 (forecast)	8.8

Sources: 2001 and 2002: Technology Futures, Inc. (2003, 47); 2003 and 2004 (Forecast): In-Stat/MDR (2004, 57); February 2004: Quinton (2004); Balhoff (2004).

calling for a flat monthly rate of $45, with extra charges for long distance and "roaming."

A key element of Microcell's offer was that consumers who switched to wireless could keep their wireline phone numbers. The program attracted over 70,000 customers in Vancouver in the first three months after it was introduced (Microcell 2004, 20). This is certainly suggestive of substitution; Microcell noted that 14 percent of City Fido subscribers said they intended to cancel their residential wireline service. City Fido's unlimited-use offer also resulted in average monthly usage that was double the normal level for Microcell customers, indicating usage substitution.

Empirical analyses have been done in a number of countries to test more rigorously the extent of substitution between cellular and wireline access and also usage. Some of the first studies were for Korea and Portugal. In both cases, the authors concluded that cellular and wireline telephony are substitutes for each other.[30] In other work, a cross-national empirical study by DotEcon (2001) that used a panel of 20 OECD countries (excluding the United States), which were observed over nine years, also found evidence of access substitution.[31] An empirical analysis by Rodini, Ward and Woroch (2003), using data from 2000-2001, provides evidence of access substitutability in the United States.[32]

30 Using 1991-1998 data, Sung and Lee (2002) find a statistically significant negative relationship between the stock of Korean cellular phones and the demand for wireline connections. A statistically significant positive relationship is found when disconnections are modelled. Together the results are a strong indication of substitutability. Barros and Cadima (2000) find a statistically significant negative relationship between Portuguese cellular phone diffusion and fixed wireline service. The introduction of cellular led to a 10 percent decrease in wireline penetration in Portugal.

31 The study finds a statistically significant effect of cellular take-up on wireline adoption. A 10 percent increase in cellular penetration leads to a 0.5 percent per annum decrease in the growth rate of wireline penetration, assuming a wireline penetration of 95 percent, cellular penetration of 70 percent, a $180 annual wireline subscription fee and per capita GDP of $18,000 (DotEcon 2001, 36).

32 Rodini, Ward and Woroch (2003) find that for every 10 percent increase in prices for wireline access in the United States, demand for cellular service increased 1.3 percent in 2001.

Given the extent to which consumers have increased their use of cellular since 2000-2001, we expect that any empirical estimates using more recent data would provide higher estimates of substitutability. Dzieciolowski and Galbraith (2004) confirm this point. Estimates of substitutability embodied in elasticity estimates that use historical data are likely to be of limited value when the price of one of the products is declining in relation to the other, as is the case with cellular in relation to wireline. As the price of the potential substitute — here cellular — continues to fall, the extent of substitution is expected to increase, and hence demand for wireline service that was formerly inelastic may become very elastic once the price difference between the products is small enough. Dzieciolowski and Galbraith (2004, 10) find that demand for wireline becomes elastic as the price difference between cellular and wireline declines to $6 to $7 a month. We are already at such levels for some plans, as Figure 1 and Appendix 1 show. As evidence of this, in recent testimony before the CRTC, Bell Canada reported that 6 percent of its wireline customer disconnects were the result of customers choosing to have only a wireless phone (CRTC 2005b).

When analyses of the substitution of wireless for wireline are based only on changes in wireline subscriptions per household, they substantially understate the extent of substitution. The reason is that the nature of the wireline product is itself changing. Many consumers now consider the primary service provided by their wireline connection to be broadband access to the Internet. They make local voice calls primarily with cellular phones and only secondarily with the home wireline connection. Since wireline service providers can offer low-cost bundles of broadband and telephone service over a single (DSL-enabled) wireline, consumers may keep their wireline service even while they shift much of their actual calling to the cellular network.

Thus, a better measure of the competition between cellular and wireline may be the amount of voice traffic carried on each network. In the United States, the large and rapid adoption of cellular has drawn significant amounts of voice traffic away from the wireline networks (Crandall 2003). The Yankee Group (2003) has estimated that 26 percent of local wireline calls and 43 percent of long distance calls have been replaced by cellular. The FCC (United States 2003, 50) cites a corroborative study noting that cellular has displaced about 30 percent of wireline minutes on average. Thus, on the basis of its share of local and long distance voice traffic, cellular has become a very clear substitute for wireline service. The findings of Ward and Woroch (2004) on usage substitution between fixed and cellular telephony in the United States provide further empirical support for this phenomenon. Making use of a large set of household survey data, Ward and Woroch (2004) find significant positive cross-price elasticities between the use of fixed wireline and cellular, from which they conclude that cellular is a moderate substitute for wireline.

Replacement of wireline by cellular is also taking place in Canada. A survey by Decima Research and Bell Canada (2003, 6) found that more than one-third of cellular users have reduced their use of wireline to some extent, and about one-half of cellular users make or receive calls on their cellular phones at home. The main reason cited for using a cellular phone in the home is that the wireline phone is tied up (Decima and Bell 2003, 33). A significant fraction (36 percent) of

respondents said there were no specific barriers impeding the adoption of cellular for a greater proportion of calls in the home (Decima and Bell 2003, 39). These results are similar to the degree of call substitution found in DotEcon's 2001 study, in which over 40 percent of U.K. consumers with access to both cellular and wireline phones chose to use their cellular phones for calls they made at home (DotEcon 2001, 10). Interestingly, the predominant reason given for call substitution in the U.K. survey was that cellular calls tend to be cheaper, which may not be true in Canada, given unlimited local wireline calling.

The extent of substitution in use is greater than that shown for access, as we would expect for the reasons noted here. In a study released in April 2004, Bell Canada compares the use of the network and the cellular system for local voice calls. For tracking done between January 1, 2004, and February 29, 2004, on a random sample of outbound calls in Ontario and Quebec on 22,000 telephone lines, 88.6 percent of all local residential voice traffic was carried over wireline networks and 11.4 percent was carried over cellular networks (Bell Canada 2004).

In economic terms there is a meaningful distinction between access and usage substitution: the extent to which usage substitution provides competitive limits on prices for wireline local access will depend on the extent of the adoption of cellular telephony. This is because local access fees in Canada are fixed, no matter how many local calls are made. Thus the transfer of calls to the cellular network does not reduce the wireline provider's revenues from local access unless consumers also cut the cord. This means that the market in which we might expect to find the most direct economic impact or competitive constraint from cellular service is the long distance market, where both wireline and cellular subscribers have traditionally paid a fee per call. It is therefore instructive that evidence from the Yankee Group (2003) suggests that over 40 percent of long distance calls in the United States are carried on the cellular network. Thus, in the long distance market it seems likely that competitive constraint and substitution in calling are present.

In contrast, access substitution disciplines the prices for wireline both directly and through its impact on interconnection fees. When cellular penetration is low, customers' calls are likely to pass through the public switched telephone network at some point, and so the incumbent will still earn revenue through interconnection fees.[33] However, when the cellular penetration rate is high, there will be a greater effect on wireline provider revenues, since fewer calls will require interconnection with the fixed network at any stage.

Summary and Implications for Regulatory Policy

At first, cellular service was viewed as a complement to wireline service, but as the price has fallen and quality has improved, it has increasingly become a substitute. As the usage studies indicate, calls made with cellular are replacing calls that used to be made with wireline. Nonetheless, only a small (albeit

33 If these access prices are regulated at levels close to the incumbent's cost, for example by means of TSLRIC (total service long run incremental cost) pricing, the incumbent will earn no profit from use by a cellular customer.

growing) number of Canadians have yet chosen to give up their wireline subscription entirely.

Differences between tariff structures and calling costs on cellular and wireline networks remain, but these do not preclude the possibility that these two services are in the same market. This is because cellular telephones provide mobility and flexibility that wireline services cannot match and that consumers value: they are differentiated products, but this in itself is not a barrier to competition. Where product differentiation is present, regulators should use a common-sense definition of markets which recognizes that consumers are substituting cellular for wireline voice services.[34]

In Canada the extent of call substitution is less than in most other OECD countries and substantially less than in developing countries where wireline networks are not ubiquitous. Low prices for wireline local service set by the CRTC contribute to slower adoption of cellular technology in Canada. The low prices, which incorporate free local calls, create large cost differences between wireline and cellular service. In the United States, where the cost difference between wireline and cellular access is smaller, wireless uptake and call substitution have both been much greater. In keeping with these lower levels of uptake and the more limited prospects for growth in cellular traffic created by the low rates for wireline local access, per capita investment in wireless networks in Canada is well below the level in the United States.

The CRTC's policy of keeping wireline local access prices low is a classic illustration of the tradeoff between static and dynamic efficiency. Low wireline prices benefit the consumers of that technology but inhibit the development of a competing technology — cellular. The lower rate of adoption of cellular technology has large dynamic efficiency costs for Canadian consumers, since the low uptake creates an environment in which expected return on investment in new technologies is reduced, investment is retarded, and new services are introduced much more slowly than in other countries. Canadians therefore pay higher prices for, and/or receive fewer services from, cellular subscriptions than consumers in other countries. Limited demand inhibits new investment and denies network operators the benefits of economies of scale. The same situation may arise with VoIP.

A dynamically competitive cellular sector in Canada would benefit all consumers of telephone services by providing lower prices, superior service and greater competitive discipline for incumbent wireline providers. It should therefore be a matter of concern to Canadian telecommunications policymakers that adoption of cellular service and the transfer of local and long distance calls to the cellular network lag behind those in other OECD countries. Because of the pervasiveness of regulation of telecommunications in Canada, regulatory policy has a substantial effect on the patterns of substitution and competition outlined above, and that in turn means that the regulatory setting has the potential to provide substantial benefits to consumers.

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34 Of course, even if cellular and wireline voice telephony form a broader single local voice communications market, the ILEC may still have a dominant position in a particular geographic market.

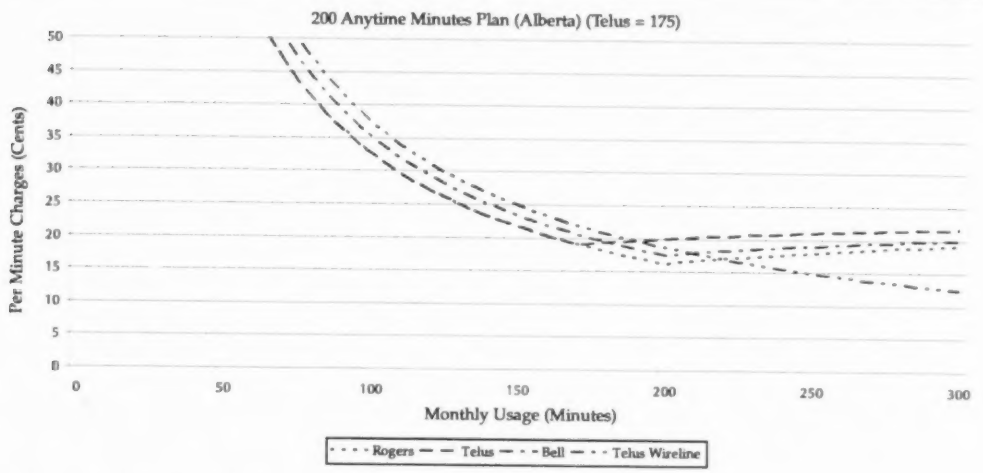
Investment in cellular technologies and coverage will not be as extensive in Canada as it is in other countries unless the prices are such as to promote efficient levels of investment in different technologies. By comparison with prices for local access in the United States, the regulated pricing of wireline service in Canada is a deterrent to the adoption of and investment in alternative technologies. In this case consumers receive the benefits of lower prices for the traditional wireline technology, and regulators may argue that their policies on pricing and service quality meet important equity goals such as service for the poor, the elderly and those in remote communities. The critical problem is that the pricing policy which is being used to meet those goals appears to be imposing large costs on Canadian society as a whole by reducing the extent of investment in and the adoption of wireless telephone technology.

The policy implications of our analysis follow. First, the CRTC should consider finding an alternative to universal low prices for local wireline service as a means of addressing any equity issues associated with the provision of wireline service. Second, the CRTC should acknowledge that the evidence of call substitution and line replacement from other countries (and Canada) suggests that despite being differentiated products, wireline and cellular services compete with each other. If prices for local wireline service were consistent with those in other countries, the price of cellular service would be closer to that of wireline service and cellular adoption and wireline call and line displacement would all increase. The price difference resulting from CRTC policy creates the impression that for most consumers in Canada, cellular and wireline local service are not substitutes and are therefore not part of the same market; this in turn perpetuates the regulations that created the price difference in the first place. Third, once it is recognized that cellular and wireline services compete, government policymakers need to consider how cellular policies affect the competitiveness of both cellular and wireline service. Foreign ownership restrictions and limited spectrum allocations will limit the number of cellular providers, thereby making cellular and wireline markets less competitive than they would be without these restrictions.

Without these changes in regulatory approach, Canadians may find themselves largely bypassed by a generation of cellular services that are at the cutting edge of telecommunications technology in every other OECD country.

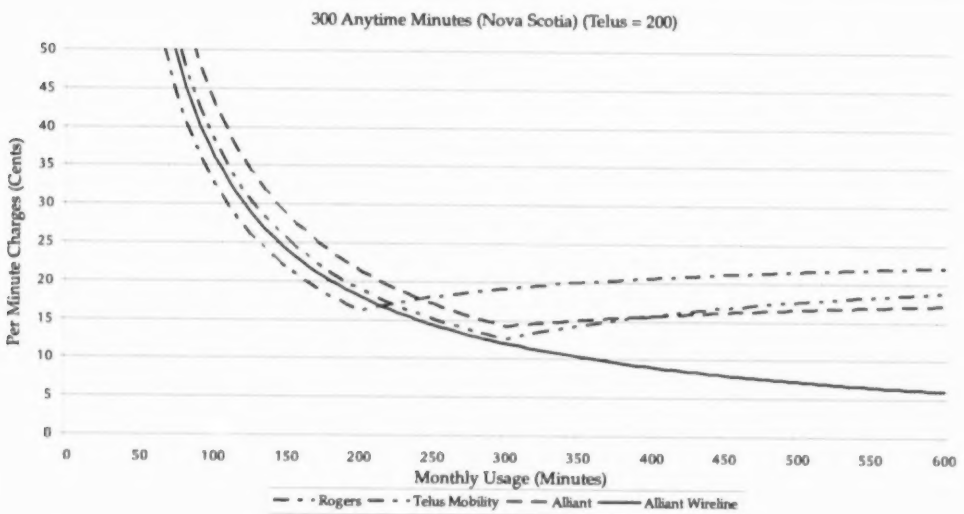
Appendix 1: Cellular and Wireline per Minute Price Comparisons

Figure A1: *200 Anytime Plan, Alberta*



Source: Company websites.

Figure A2: *300 Anytime Plan, Nova Scotia*



Source: Company websites.

Appendix 2: Regression Analysis

Regression analysis allows us to isolate statistically the effect of wireline prices on cellular penetration while controlling for other changes over time and differences across countries. We use annual data provided by the International Telecommunications Union (ITU 2004) for all 30 OECD countries from 1993 to 2002.

The variable we are trying to explain in the regression analysis is the cellular penetration level, which is equal to total cellular subscribers divided by population.[35] The variables that might "explain" cellular penetration across countries and time are a series of cost and demand drivers. In the model, we test the extent to which cellular penetration is "explained" by the following variables: wireline penetration, cellular revenue per subscriber as a proxy for cellular prices, wireline revenue per subscriber and the cost of a three-minute local wireline call (at peak) as measures of wireline prices, gross domestic product (GDP) per capita as a measure of income, and various control variables for different-country fixed effects and different-year effects. Our choice of variables is limited by the availability of data.[36]

In order to have comparable prices, we convert cellular revenue per subscriber, wireline revenue per subscriber, GDP per capita and the cost of a three-minute local (wireline) call into U.S. dollars, using the annual average exchange rate for the particular country. We also deflate each of these variables by each country's annual consumer price index (CPI) in order to account for general inflation.[37] Table A-1 summarizes the mean values by country of the variables of interest.

Our regression model is linear in logarithms, a practice that is common in econometric analysis.[38] Use of this specification allows us to interpret the estimated coefficients as percentage changes over percentage changes.[39] The general regression model is:

$$\log(CellPenetr_{it}) = \alpha + \beta_1 \times \log(WirePenetr_{it}) + \beta_2 \times \log(CellRvPerSubs_{it}) + \beta_3 \times \log(WireRvPerSubs_{it}) + \beta_4 \times \log(GDPperCapita_{it}) + \beta_5 \times \log(WireCall3MinCost_{it}) + \beta_6 \times Trend_t \times \gamma_i + \varepsilon$$

where i indexes country, t indexes time and γ is the country fixed effect.

35 This is known as the "dependent" variable since it is dependent on the other variables. For example, if we were estimating how income is affected by education and age, income would be the dependent variable, which is explained by education and age — the "explanatory" variables.

36 For example, data on the cost of a three-minute local cellular call were less available, and hence we chose not to use it in our main specification. We did, however, add this variable to the regressions as part of our sensitivity analysis. We were also interested in including a variable to measure the percentage of the country's population for which cellular access is available and which is included in the ITU database. However, the number of entries missing for this variable limited our use of it in the regression.

37 All data, including the country CPIs and exchange rates, are from the ITU's World Telecommunication Indicators Database (ITU 2004). The CPIs use 1995 as the base year.

38 The specification provides the functional form, or "shape," of the function that is being estimated. Linear in logarithms means we estimate a linear equation by taking the natural logarithm of the dependent and explanatory variables.

39 The coefficient estimate of GDP per capita, for example, is the estimate of how much the differences in GDP per capita across countries and over time explain the differences in cellular penetration. Thus, if the coefficient estimate is equal to 0.10, this tells us that a 10 percent increase in GDP per capita is consistent with about a 1 percent increase in cellular penetration.

The variables of interest to us are wireline revenue per subscriber and the cost of a three-minute local wireline call, which measures the marginal cost of an additional local call. In Canada, the marginal cost of a three-minute local call is equal to zero. In addition to being interested in the measured importance of these variables (denoted by the coefficient estimate), we are also interested in whether they are important statistical influences on cellular penetration.[40]

We expect the following relations between variables. Cellular penetration should be positively correlated with wireline penetration and with GDP per capita (our measure of income), in that countries with higher incomes should have higher cellular penetration and also higher wireline penetration. We should also find cellular penetration increasing over time as technology improvements have increased the demand for cellular phones. Lower cellular prices should be associated with higher cellular penetration, and hence cellular revenue per subscriber — our indicator of average cellular price — should be negatively correlated with penetration. If wireline and cellular are substitutes, we should find that cellular penetration is positively correlated with wireline prices; i.e., as wireline prices rise, cellular penetration should rise. We have two measures for wireline prices: wireline revenue per subscriber, which represents the average wireline price per subscriber; and the cost of a three-minute local wireline call at peak hours. We expect to find a stronger positive relation with the cost of a three-minute local call and cellular penetration, because in countries with free local wireline calling, consumers are expected to be less willing to cut the cord on their wireline phone than in countries with metered local wireline calling. Table A-2, which summarizes the correlations between cellular penetration and each independent variable in the regression by country, confirms these expectations.[41]

The regression results (reported in Table A-3) confirm our hypothesis that cellular penetration is affected by wireline prices after other possible influences are controlled for. As the table shows, the coefficients on wireline revenue per subscriber and the cost of a three-minute local call are positive, although only the cost of a three-minute wireline call is statistically significant. In particular the results show that if the cost of a three-minute local wireline call were to double, cellular penetration would increase by 20 percent. This is highly statistically significant, and hence we are confident the result is not due to chance.

40 When estimates are measured with precision (i.e., when the statistical significance is calculated), we can be confident that the estimated relationship did not arrive by chance. In particular, a coefficient significant at the 5 percent level means that if the analysis were repeated 20 times with a different random sample each time, and if there were in fact no relationship between the dependent variable and the explanatory variable at issue, in only 1 out of 20 repetitions would the coefficient estimate for the explanatory variable at issue be at least as large (in absolute value) as what we have estimated. An estimate that is statistically significant at the 1 percent level is even less likely (once in 100 repeated trials) to indicate a relationship only by chance.

41 Although negative correlations between cellular penetration and wireline revenue per subscriber are more frequent than positive correlations, the correlation between the cost of a three-minute local wireline call and cellular penetration is far more often positive.

Table A-1: *Mean Values of Data by Country (deflated by country-specific inflation and all currencies converted to US dollars)*

Country	Cellular Penetration	Wireline Penetration	Cellular Revenue per Subscriber	Wireline Revenue per Subscriber	GDP per Capita	Cost of 3-min Local Wireline Call
	%		$			
Australia	30	51	507.00	636.31	19,786.26	0.16
Austria	36	48	562.02	717.03	25,767.89	0.18
Belgium	27	48	1,082.10	668.11	23,965.51	0.17
Canada	19	64	536.36	468.90	21,631.03	0.00
Czech Republic	23	31	781.36	282.28	5,117.68	0.09
Denmark	39	65	465.61	494.40	31,411.72	0.14
Finland	47	55	459.46	342.91	23,189.00	0.13
France	25	57	797.32	504.40	24,115.95	0.13
Germany	27	56	855.81	579.85	25,342.14	0.13
Greece	29	51	612.72	410.34	10,922.42	0.05
Hungary	19	29	947.20	336.34	4,668.13	0.11
Iceland	42	62	371.91	587.24	26,868.22	0.10
Ireland	32	42	541.58	906.96	22,013.23	0.16
Italy	39	45	444.18	654.84	19,600.46	0.13
Japan	32	49	1,425.02	810.97	35,524.29	0.09
Korea	30	45	708.89	275.06	9,411.59	0.04
Luxembourg	39	67	478.09	814.33	42,609.71	0.28
Mexico	8	11	344.09	809.70	4,749.98	0.13
Netherlands	31	57	1,013.01	564.72	23,795.60	0.15
New Zealand	27	46	454.20	696.25	14,926.42	0.00
Norway	46	65	477.59	539.41	34,610.58	0.13
Poland	10	21	1,229.33	314.20	3,721.21	0.07
Portugal	33	39	688.31	513.72	10,405.61	0.09
Slovak Republic	14	25	155.08	226.08	3,625.59	0.09
Spain	29	40	615.87	535.26	14,049.63	0.09
Sweden	46	71	411.11	410.63	26,857.99	0.11
Switzerland	32	67	756.76	805.33	36,982.84	0.17
Turkey	11	25	279.74	207.66	2,792.73	0.08
United Kingdom	35	54	500.02	554.10	21,826.77	0.19
United States	25	63	558.78	993.34	31,259.87	0.00

Source: ITU 2004.

Table A-2: *Correlation Coefficients of Cellular Penetration with Each Independent Variable by Country*

Country	Wireline Penetration	Cellular Revenue per Subscriber	Wireline Revenue per Subscriber	GDP per Capita	Cost of 3 - min Local Wireline Call
Australia	0.98	-0.97	-0.93	0.18	-0.87
Austria	0.47	-0.97	-0.90	-0.42	-0.48
Belgium	0.68	-0.80	0.76	-0.42	-0.88
Canada	0.71	-0.98	-0.88	0.94	na
Czech Republic	0.67	-0.78	-0.42	0.67	0.71
Denmark	0.94	-0.97	-0.70	0.03	-0.80
Finland	-0.41	-0.55	0.36	0.58	-0.50
France	0.54	-0.84	-0.94	-0.44	-0.37
Germany	0.91	-0.84	-0.88	-0.63	-0.92
Greece	0.45	-0.74	-0.36	0.36	0.84
Hungary	0.69	-0.76	-0.27	0.93	0.04
Iceland	0.89	-0.77	-0.24	0.68	0.02
Ireland	0.93	-0.93	-0.91	0.89	-0.87
Italy	0.97	-0.88	-0.11	0.23	-0.88
Japan	-0.11	-0.79	-0.55	-0.61	-0.74
Korea	0.88	-0.88	-0.84	-0.06	-0.68
Luxembourg	0.94	-0.83	-0.78	0.66	0.81
Mexico	0.99	-0.74	-0.67	0.90	0.60
Netherlands	0.90	-0.87	-0.60	0.33	-0.86
New Zealand	0.12	-0.93	0.07	-0.28	n.a.
Norway	0.99	-0.87	-0.92	0.83	0.72
Poland	0.87	-0.72	-0.15	0.79	0.96
Portugal	0.83	-0.89	-0.86	0.62	0.95
Slovak Republic	0.53	-0.08	-0.15	0.57	0.85
Spain	0.90	-0.90	-0.84	0.64	-0.74
Sweden	0.93	-0.91	-0.56	0.12	0.45
Switzerland	0.95	-0.93	-0.94	-0.49	-0.69
Turkey	0.74	-0.76	0.34	-0.34	0.94
United Kingdom	0.91	-0.87	0.03	0.84	-0.63
United States	0.88	-0.32	0.90	0.99	n.a.

Source: ITU 2004.

Table A-3: *Regression Results*[a] *(Dependent Variable — Cellular Penetration)*

Independent Variables	Coefficient Estimate	T-statistic
Wireline penetration (logs)	2.187**	7.18**
Cellular rev. per subs. — deflated (logs)	-0.706**	-8.65**
Wireline rev. per subs. — deflated (logs)	0.064	0.35
GDP per Capita — Deflated (logs)	0.173	0.95
Cost of 3 = min. local wireline call — deflated (logs)	0.205**	5.86**
Time trend	0.266**	16.20**
Constant	-526.423**	16.11**
Number of observations		267.00
Number of countries		30.00
R-squared — within		0.94

Note: [a] Panel data regressions with country as the cross-section unit, fixed effects model.

* Significant at the 5% level; ** Significant at the 1% level.

We also find plausible results for the other variables:

- Higher wireline penetration is associated with higher cellular penetration and is statistically significant. Countries with higher wireline penetration will have greater diffusion of technology among the general population, and this greater diffusion is expected to generate higher cellular penetration.
- Higher cellular revenue per subscriber, which is our proxy for cellular prices, is associated with lower cellular penetration and is statistically significant. Thus, higher cellular prices are associated with lower cellular penetration. Limited cellular penetration will also mean reduced economies of scale and fewer prospects for entry.
- Higher GDP per capita, which is our measure for income, is associated with higher cellular penetration, although this is not statistically significant.
- The time trend variable is positive and statistically significant, reflecting increasing cellular penetration as the technology is more widely diffused and technical improvements are made.

To test the robustness of these results, we ran the model with dummy variables for each year as opposed to a time trend. The results were not materially different. We also included the cost of a three-minute cellular call (at peak) in some of the regressions but had to omit some countries and years owing to missing data. The

variable for the cost of a three-minute cellular call is positive but not statistically significant in explaining cellular penetration. On the other hand, cellular revenue per subscriber remains negative and highly statistically significant. Wireline revenue per subscriber and the cost of a three-minute wireline call also remain positive in this specification. The cost of a three-minute wireline call also stays highly statistically significant in explaining cellular penetration, with a larger coefficient than in the main specification. However, GDP per capita becomes negative but is not statistically significant at the 5 percent level.

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